1. PUBLIC HEALTH STATEMENT

This Statement was prepared to give you information about zinc and to emphasize the human health effects that may result from exposure to it. The Environmental Protection Agency (EPA) has identified 1,350 hazardous waste sites as the most serious in the nation. These sites comprise the "National Priorities List" (NPL): Those sites which are targeted for long-term federal cleanup activities. Zinc has been found in at least 776 of the sites on the NPL. However, the number of NPL sites evaluated for zinc is not known. As EPA evaluates more sites, the number of sites at which zinc is found may increase. This information is important because exposure to zinc may cause harmful health effects and because these sites are potential or actual sources of human exposure to zinc.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You can be exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking substances containing the substance or by skin contact with it.

If you are exposed to a substance such as zinc, many factors will determine whether harmful health effects will occur and what the type and severity of those health effects will be. These factors include the dose (how much), the duration (how long), the route or pathway by which you are exposed (breathing, eating, drinking, or skin contact), the other chemicals to which you are exposed, and your individual characteristics such as age, gender, nutritional status, family traits, life-style, and state of health.

1.1 WHAT IS ZINC?

Zinc is one of the most common elements in the earth's crust. Zinc is found in the air, soil, and water and is present in all foods. In its pure elemental (or metallic) form, zinc is a bluish-white shiny metal. There is no information on the taste and odor of metallic

zinc. Powdered zinc is explosive and may burst into flames if stored in damp places. Metallic zinc has many uses in industry. A common use is as coating for iron or other metals so that they do not rust or corrode. Metallic zinc is also mixed with other metals to form alloys such as brass and bronze. A zinc and copper alloy is used to make pennies in the United States. Metallic zinc is also used to make dry cell batteries.

Zinc can also combine with other elements, such as chlorine, oxygen, and sulfur, to form zinc compounds. Zinc compounds that may be found at hazardous waste sites are zinc chloride, zinc oxide, zinc sulfate, and zinc sulfide. This profile focuses primarily on metallic zinc and commonly found or used zinc compounds. Most zinc ore found naturally in the environment is in the form of zinc sulfide. Zinc compounds are widely used in industry. Zinc compounds are not explosive or flammable. Zinc sulfide is gray-white or yellow-white, and zinc oxide is white. Both of these compounds are used to make white paints, ceramics, and several other products. Zinc oxide is also used in producing rubber. Zinc compounds, such as zinc acetate, zinc chloride, and zinc sulfate, are used in preserving wood and in manufacturing and dyeing fabrics. Zinc chloride is also the major ingredient in smoke from smoke bombs. Zinc compounds are also used by the drug industry as ingredients in some common products, such as sun blocks, diaper rash ointments, deodorants, athlete's foot preparations, acne and poison ivy preparations, and antidandruff shampoos.

Zinc is an essential food element needed by the body in small amounts. Too little zinc in the diet can lead to poor health, reproductive problems, and lowered ability to resist disease. Too much zinc can also be harmful to health. More information can be found on the chemical and physical properties of zinc in Chapter 3 and on its occurrence and fate in the environment in Chapter 5.

1.2 WHAT HAPPENS TO ZINC WHEN IT ENTERS THE ENVIRONMENT?

Zinc enters the air, water, and soil as a result of both natural processes and human activities. Most zinc enters the environment as the result of human activities, such as

mining, purifying of zinc, lead, and cadmium ores, steel production, coal burning, and burning of wastes. These releases can increase zinc levels in the atmosphere. Waste streams from zinc and other metal manufacturing and zinc chemical industries, domestic waste water, and run-off from soil containing zinc can discharge zinc into waterways. The level of zinc in soil increases mainly from disposal of zinc wastes from metal manufacturing industries and coal ash from electric utilities. In air, zinc is present mostly as fine dust particles. This dust eventually settles over land and water. Rain and snow aid in removing zinc from air. Most of the zinc in bodies of water, such as lakes or rivers, settles on the bottom. However, a small amount may remain either dissolved in water or as fine suspended particles. The level of dissolved zinc in water may increase as the acidity of water increases. Some fish can collect zinc in their bodies if they live in water containing zinc. Most of the zinc in soil is bound to the soil and does not dissolve in water. However, depending on the characteristics of the soil, some zinc may reach groundwater. Contamination of groundwater from hazardous waste sites has been noticed. Zinc may be taken up by animals eating soil or drinking water containing zinc. If other animals eat these animals, they will also have increased amounts of zinc in their bodies. For more information about what happens to zinc in the environment, see Chapter 5.

1.3 HOW MIGHT I BE EXPOSED TO ZINC?

We are exposed to small amounts of zinc compounds in food every day. The average daily zinc intake through the diet in this country ranges from 7 to 16.3 milligrams (mg). Food may contain levels of zinc ranging from approximately 2 parts of zinc per million (ppm) parts of foods (e.g., leafy vegetables) to 29 ppm (meats, fish, poultry). Zinc is also present in most drinking water. Drinking water or other beverages may contain high levels of zinc if they are stored in metal containers or flow through pipes that have been coated with zinc to resist rust. Drinking water may also be contaminated by zinc from industrial sources or toxic waste sites. High-level exposure to zinc may also result from taking too many zinc dietary supplements. Fetuses and nursing children may be exposed to the zinc in the blood or milk of their mothers.

In general, levels of zinc in air are relatively low and fairly constant. Average levels of zinc in the air throughout the United States are less than 1 microgram of zinc per cubic meter ($\mu g/m^3$) of air, but range from 0.1 to 1.7 $\mu g/m^3$ in areas near cities. Air near industrial areas may have higher levels of zinc. The average zinc concentration for a l-year period was 5 $\mu g/m^3$ in one area near an industrial source.

About 150,000 workers are exposed to zinc at their jobs. Jobs where people are exposed to zinc include zinc mining, smelting, and welding; manufacture of brass, bronze, or other zinc-containing alloys; manufacture of galvanized metals; and manufacture of machine parts, rubber, paint, linoleum, oilcloths, batteries, some kinds of glass and ceramics, and dyes. People at construction jobs, automobile mechanics, and painters are also exposed to zinc.

For more information on exposure to zinc, see Chapter 5.

1.4 HOW CAN ZINC ENTER AND LEAVE MY BODY?

Zinc can enter the body through the digestive tract if you eat food or drink water containing it. Zinc can also enter through your lungs if you inhale zinc dust or fumes from zinc-smelting or zinc-welding operations on your job. The amount of zinc that passes directly through the skin is relatively small. The most likely route of exposure near NPL waste sites is through drinking water containing a high amount of zinc. Zinc is stored throughout the body. Zinc increases in blood and bone most rapidly after exposure. Zinc may stay in the bone for many days after exposure. Normally, zinc leaves the body in urine and feces. More information on how zinc enters and leaves your body can be found in Chapter 2.

1.5 HOW CAN ZINC AFFECT MY HEALTH?

Inhaling large amounts of zinc (as zinc dust or fumes from smelting or welding) can cause a specific short-term disease called metal fume fever. However, very little is known about the long-term effects of breathing zinc dust or fumes.

Taking too much zinc into the body through food, water, or dietary supplements can also affect health. The levels of zinc that produce adverse health effects are much higher than the Recommended Dietary Allowances (RDAs) for zinc of 15 mg/day for men and 12 mg/day for women. If large doses of zinc (10-15 times higher than the RDA) are taken by mouth even for a short time, stomach cramps, nausea, and vomiting may occur. Ingesting high levels of zinc for several months may cause anemia, damage the pancreas, and decrease levels of highdensity lipoprotein (HDL) cholesterol. We do not know if high levels of zinc affect the ability of people to have babies or cause birth defects in humans.

Eating food containing very large amounts of zinc (1,000 times higher than the RDA) for several months caused many health effects in rats, mice, and ferrets, including anemia and injury to the pancreas and kidney. Rats that ate very large amounts of zinc became infertile. Rats that ate very large amounts of zinc after becoming pregnant had smaller babies. Putting low levels of certain zinc compounds, such as zinc acetate and zinc chloride, on the skin of rabbits, guinea pigs, and mice caused skin irritation. Skin irritation from exposure to these chemicals would probably occur in humans. EPA has determined that zinc is not classifiable as to its human carcinogenicity.

Consuming too little zinc is at least as important a health problem as consuming too much zinc. Without enough zinc in the diet, people may experience loss of appetite, decreased sense of taste and smell, decreased immune function, slow wound healing, and skin sores. Too little zinc in the diet may also cause poorly developed sex organs and retarded growth in young men. If a pregnant woman does not get enough zinc, her babies may have growth retardation.

More information on the health effects linked with exposure to higher than normal levels of zinc is presented in Chapter 2.

1.6 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO ZINC?

A medical test exists that can determine whether your body fluids contain high levels of zinc. Samples of blood or feces can be collected in a doctor's office and sent to a laboratory that can measure zinc levels. It is easier for most laboratories to measure zinc in blood than in feces. The presence of high levels of zinc in the feces can mean recent high zinc exposure. High levels of zinc in the blood can mean high zinc consumption and/or high exposure. High zinc levels in blood or feces reflect the level of exposure to zinc. Measuring zinc levels in additional fluids (e.g., urine and saliva) would probably provide more information about zinc exposure. Tests to measure zinc in hair may provide information on long-term zinc exposure. However, no quantitative correlation has been found between hair zinc levels and zinc exposure. These tests are not routinely used. More information on tests to measure zinc in the body can be found in Chapter 6.

1.7 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government has set standards and guidelines to protect individuals from the potential health effects of excessive zinc. EPA has stated that drinking water should contain no more than 5 mg of zinc per liter of water (5 mg/L, or 5 ppm) because of taste. Furthermore, any release of more than 1,000 pounds (or in some cases 5,000 pounds) of zinc or its compounds into the environment (i.e., water, soil, or air) must be reported to EPA.

The National Academy of Sciences (NAS) estimates an RDA for zinc of 15 mg/day (men). Fifteen mg/day is the same as 0.21 mg per kilogram (kg) of body weight per day for an average adult male (70 kg). An RDA of 12 mg/day was established for women

because they usually weigh less than men. Lower zinc intake was recommended for infants (5 mg/day) and children (10 mg/day) because of their lower average body weights. The RDA provides a level of adequate nutritional status for almost the entire population. Extra dietary levels of zinc are recommended for women during pregnancy and lactation. An RDA of 15 mg/day was set for pregnant women. Women who nurse their babies need 19 mg/day during the first 6 months and 16 mg/day during the second 6 months of nursing.

To protect workers, the Occupational Safety and Health Administration (OSHA) has set a legal limit of 1 mg/m^3 for zinc chloride in workroom air. This regulation means that the workroom air should contain no more than an average of 1 mg/m^3 of zinc chloride over an 8-hour working shift of a 40-hour workweek. The National Institute for Occupational Safety and Health (NIOSH) recommends that the level of zinc oxide in workplace air should not exceed an average of 5 mg/m^3 over a lo-hour period of a 40-hour work week. For more information on recommendations and standards for zinc exposure, see Chapter 7.

1.8 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or:

Agency for Toxic Substances and Disease Registry

Division of Toxicology

1600 Clifton Road NE, E-29
Atlanta, Georgia 30333

(404) 639-6000

This agency can also provide you with information on the location of occupational and environmental health clinics. These clinics specialize in the recognition, evaluation, and treatment of illness resulting from exposure to hazardous substances,